

KENYA COASTAL DEVELOPMENT PROJECT (KCDP)

Report on Prioritization of Key Commercial Species for Stock Assessment

COMPONENT 1: SUSTAINABLE MANAGEMENT OF FISHERIES RESOURCES
SUBCOMPONENT 1.2: RESEARCH

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Editors

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Table of Contents

1.0 Introduction.....	4
2.0 Objectives	4
3.0 Methodology.....	4
3.1 Scoping (Stage 1): Profiling and Documentation of General Fishery Characteristics.....	6
3.2 Scoping (Stage 2): Generating the Unit of Analysis	7
3.3 Level 2: Productivity Susceptibility Analysis (PSA).....	7
4.0 Summary of PSA Outputs.....	9
4.1 Availability of Information	10
5.0 Prioritization of Key Commercial Species for Quantitative Assessment	10
6.0 References.....	15

1.0 Introduction

The general status of Kenya's inshore marine and coastal fish stocks remains uncertain due to inadequate information to form a reliable assessment of status. Understanding the current status and exploitation of key commercial fish stocks (target and bycatch species) and their vulnerability to overfishing is an important step in generating the baseline data and information needed to guide the development of appropriate management strategies. In line with the KCDP Project Development Objective (PDO) of improving management effectiveness and enhancing revenue generation of Kenya's coastal and marine resources and the Global Environmental Objective (GEO) of strengthening conservation and sustainable use of marine and coastal biodiversity, the Research Subcomponent plans to conduct stock assessments of selected key commercial fisheries to contribute to intermediate result indicator four: *number of key exploited species with stock status established*. Towards this, the need to undertake a risk assessment of the key commercial species based on a framework adapted from Hobday et al (2007) was identified to guide the prioritization of key species for stock assessment. This document provides a summary of the process that was undertaken to identify and prioritize species under high risk of overfishing.

2.0 Objectives

The specific objectives of this activity were to:

1. To collate and review existing information on key commercial fisheries along the Kenyan coast
2. Conduct a risk assessment of the key commercial fisheries and identify potential priority species for stock assessment

3.0 Methodology

Working groups were established consisting of fisheries scientists from KMFRI, FID, WCS, CORDIO, Nairobi University and University of Eldoret (Table 1). A series of consultative meetings and workshops were convened in October to February 2013 to impel the process (Table 2). The working groups each undertook the task of collating information on 14 key fisheries: prawns, small/medium pelagics - (seine nets: ringnets, seine nets, handlines and gillnets), marine ornamentals, lobster, basket traps, recreational trolling line, octopus, mud crabs, sea cucumbers, and coastal lakes and rivers, the results of which will be documented in a more detailed report.

An ecological risk assessment for the effects of fishing (ERAEF) framework by Hobday et al (2007) was adapted to screen out potentially vulnerable species in each fishery. The ERAEF framework provides a hierarchical approach for assessing the ecological risks arising from fishing, with impacts assessed against five ecological components – target species; by-product and by-catch species; threatened, endangered and protected (TEP) species; habitats; and (ecological)

communities. ERAEF proceeds through four stages of analysis: scoping; an expert judgement based Level 1 analysis (SICA – Scale Intensity Consequence Analysis); an empirically based Level 2 analysis (PSA – Productivity Susceptibility Analysis); and a model based Level 3 analysis.

Table 1. Composition of fishery working groups that undertook the fishery assessments

	Fishery Working Groups:	Contributors:
1	Basket trap /Mud crab/Coastal lakes & rivers	Nina Wambiji, Emmanuel Mbaru, Johnstone Omukoto, Rashid Anam, Dorcas Sigana, Caroline Abunge
2	Lobster/ Sea cucumber fisheries	Elizabeth Mueni, Almubarak Athman, Harrison Ong’anda, Edward Kimani
3	Marine ornamental fishery	Gladys Okemwa, Benrick Ogutu, Jane Nyamora
4	Octopus fishery	Nina Wambiji, Rashid Anam, Jane Nyamora
5	Prawn fishery	Bernard Fulanda, Edward Kimani, Collins Ngoro, Khyria Swaleh
6	Longline fishery	Benedict Kiilu
7	Beachseine fishery	Robinson Mugo, Steven Ndegwa, Benedict Kiilu
8	Ringnet fishery	George Waweru, Pascal Thoya
	Handline fishery	Joel Amisi
	Gillnet fishery	Lenjo Mrombo
	Recreational trolling (Sport fishery)	Peter Nyongesa
9	Technical Facilitator	Julius Manyala
	Team Leader / Report Compilation	Gladys Okemwa

Table 2: Summary of the Process

Dates	Activity	Method
30/10/2012 - 13/11/2012	<u>Scoping</u> : Literature review (metadata, technical reports and publications) to characterize key commercial fisheries and identify data gaps	Working group meeting at KMFRI and a two week assignment
14/11/2012	<u>Scoping</u> : Progress update on fishery characterization by working groups	Working group meeting at KMFRI
27/11/2012 - 2/12/2012	<u>Risk assessment</u> : Validation of scoping, and scoring of PSA attributes	Stakeholder consultative workshop in Kilifi
15/12/2012	Review and validation of PSA outputs	Working group meeting at KMFRI
13/02/2013 – 16/02/2013	Selection of priority species and agreement on attributes for assessment	Expert working group to select priority species in Kilifi

3.1 Scoping (Stage 1): Profiling and Documentation of General Fishery Characteristics

An overview of the ERAEF framework is shown in Figure 1. The first step was the scoping stage which was undertaken to provide a detailed profile of each fishery. The working groups were tasked to collate and review all existing information which included a historical overview of the fishery, a summary of spatial coverage of the fishery indicating key fishing grounds, target and bycatch species, prevalence of resource use conflicts, conservation concerns and any other pertinent issues. The teams used various sources of including, journal publications, grey literature (technical and data summary reports), thesis documents, management plans and regulations, WioFish database (www.wiofish.org), journal articles, and fisheries frame survey reports. From this process it was observable that the range of available information on each fishery varied with some fisheries having more up to date reliable information while others having very limited information.

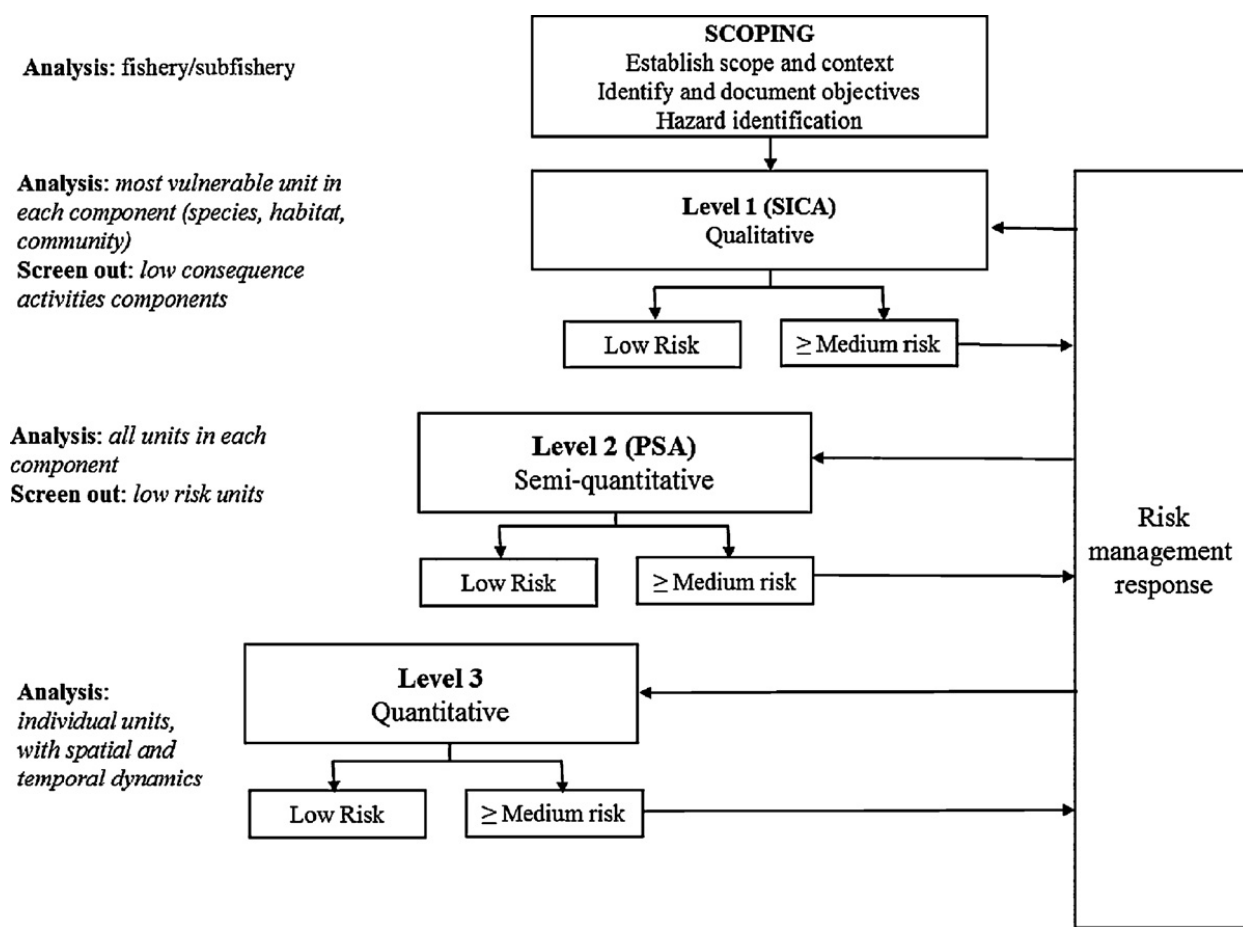


Figure 1. Overview of the ERAEF framework showing focus of analysis for each level in the hierarchy at the left in italics. At each level a risk management response is an alternative to proceeding to the next level in the hierarchy (Hobday et al 2011)

3.2 Scoping (Stage 2): Generating the Unit of Analysis

The unit of analysis is focused on the species components which includes target, bycatch, discards, threatened and endangered and protected species (TEP). The working groups generated a species list derived from observer and logbook data, catch monitoring records and related publications.

3.3 Level 2: Productivity Susceptibility Analysis (PSA)

Level 2 Productivity and Susceptibility Analysis (PSA) adapted from Hobday *et al.* (2007) was employed to rank the species and prioritize those that are potentially at risk from the impacts of fishing. The approach measures the direct impacts of fishing on all species identified based on the assumption that the risk of an impacted population will depend on two characteristics: (1) the extent of the impact due to fishing activities (Susceptibility) and (2) the ability of the species to recover after potential depletion or damage by fishing activities (Productivity). Each species was scored against a set of predetermined measurable attributes that contribute to or reflect a species' susceptibility or productivity (Table 3). The attributes were scored on a three point scale as shown in Tables 4 and 5.

The baseline information for scoring the biological and ecological attributes for each species was obtained from publications (journals, thesis, and technical reports). When local information was unavailable, taxonomic websites such as Fishbase (<http://www.fishbase.org>) were used to obtain regional species specific. In the absence of both local and regional information, an attribute was either ranked a default high risk score of 3 as recommended by Hobday et al (2007) or expert opinion was used to rank the scores based on local knowledge of the species and fishery. The attribute scores assigned for each species were then reviewed and validated for accuracy. The resulting outputs provided a relative screening of species which were ranked as: low (>1.41), medium (>2.64), or high (>3.18). The list of species which rank of medium and high were then screened out to provide a list of potential priority species.

Table 3: Productivity and susceptibility attributes used to score the risks

Productivity Attributes	Population doubling time	
	Longevity	
	Fecundity	
	Maximum size	
	Average size at maturity	
	Reproductive strategy	
Mean trophic level		
Susceptibility Attributes	Availability	Areal overlap: the likelihood that fishing effort occurs within a species distribution, taking into account species specific behaviors
	Encounterability	Vertical overlap: the likelihood that a species will be encountered a fishing gear when deployed within the depth range of the species
	Selectivity	Selectivity: the potential of the species to be captured or retained
		Desirability: the value of the species to the fishery
	CPUE	Volume of landed catches
Management strategy	Management strategies in place for affected fish stocks	

Table 4. Cut-off scores used for the productivity attributes

Criteria	Description	Low	Medium	High
		(High Risk)	(Medium)	(Low)
		3	2	1
Fecundity	Fecundity	<1000 eggs/year	1000-20,000 eggs/year	>20,000 eggs/year
Longevity	Maximum age (other fisheries)	>25 years	10-25 years	<10 years
	Maximum age (crustaceans/ornamentals)	>10 years	1-10 years	up to one year
Maximum Size	Average maximum size	>150 cm	60-150 cm	<60 cm
Size at maturity	Average size at maturity	>200 cm	40-200 cm	<40 cm
Reproduction	Reproductive strategy	Live bearer	Demersal egg layer	Broadcast spawner
Trophic level	Mean trophic level	>3.5	2.5-3.5	<2.5
Population doubling time	Population doubling time	>4.4 years	1.4 - 4.4 years	<15months

Table 5. Cut-off scores used for the susceptibility attributes

	Low risk (1)	Medium Risk (2)	High Risk (3)
Management Strategy	Targeted stocks have catch limits and proactive management measures; non-target stocks are closely monitored.	Targeted stocks have catch limits and reactive accountability measures	Targeted stocks do not have catch limits or accountability measures; non-target stocks are not closely monitored.
Availability (areal overlap)	< 25% of stock occurs in the area fished	Between 25% and 50% of the stock occurs in the area fished	> 50% of stock occurs in the area fished
Encounterability (vertical overlap)	< 25% of stock occurs in the depths fished	Between 25% and 50% of the stock occurs in the depths fished	> 50% of stock occurs in the depths fished
Selectivity (catchability)	gear attributes inappropriate to catch the species	gear attributes suggest some captures, but escapement likely	gear attributes appropriate for the species
Selectivity (desirability/value of the fishery)	stock is not highly valued or desired by the fishery	stock is moderately valued or desired by the fishery	stock is highly valued or desired by the fishery

4.0 Summary of PSA Outputs

A summary of the number of species assessed in each fishery is presented in Table 6. Species that ranked in the upper third (risk value > 3.18) and middle third ($2.64 < \text{risk value} < 3.18$) in the PSA model were deemed to be potentially risk. A total of 120 species were screened out as priority species (i.e) those ranked at medium and high risk (Table 7). By taxa, the list of priority species comprised of 76 teleost (bony fishes), 16 chondrichthyans (sharks and rays), and 28 invertebrates. The full list of species and actual rankings for the species screened to be potentially vulnerable to overexploitation is shown in Appendix 1.

Table 6 Number of species assessed in each fishery

	Fishery	Target Species	Bycatch Species	TOTAL
1	Lobster	9	0	9
2	Octopus	3	0	3
3	Prawn	5	15	21
4	Basket trap	24	6	30
5	Ornamental	102	0	102
6	Ringnet	30	0	30
7	Beachseine	18	0	18
8	Longline	21	0	21
9	Recreational trolling	14	0	14
10	Sea cucumber	17	0	17
11	Gillnet	43	0	43
12	Handline	27	0	27
13	Coastal lakes and rivers	24	0	24
14	Mud crabs	2	2	4

Table 7. Summary of overall risk scores for the key commercial fisheries stocks that were assessed

	Fishery	High	Medium	Low
1	Lobster	1	6	2
2	Octopus	0	0	3
3	Prawn	0	13	32
4	Basket trap	2	14	14
5	Ornamental	5	34	63
6	Ringnet	3	5	21
7	Beachseine	4	9	5
8	Longline	3	3	15
9	Recreational trolling	0	3	11
10	Sea cucumber	2	9	6
11	Gillnet	5	7	30
12	Handline	0	0	27
13	Coastal lakes and rivers	0	11	15
14	Mud crabs	0	0	4

4.1 Availability of Information

Application of the PSA methodology revealed missing data for many of the productivity attributes. Most of the species were found to be relatively data-limited with very little research done on their life history with no information on the volume of catches, changes in catch composition and little or no fishery-independent species information on spatial distribution. Thus, either expert opinion was used or a default score of high risk was given. Further studies should be conducted indicator species that will be prioritized for the fisheries that were assessed. Appropriate strategies should be put in place to enable long term monitoring of the selected species as an indicator of stock status.

5.0 Prioritization of Key Commercial Species for Quantitative Assessment


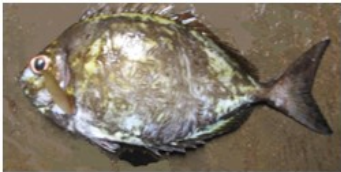

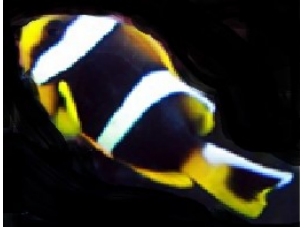









Thirty six species were initially selected (Table 8), based on the outcomes of the PSA screening and expert opinion on volume of landed catches, and gear overlap indicating level of fishing pressure and availability of the species for biological studies. This list was further narrowed down to a final list of 13 priority species for a level 3 quantitative stock assessment as shown in Table 9. For stock assessment, the selected species were further prioritized into 3 groups:

- **Group 1 (M&E) species** - indicator species for fishery management plans that will be developed under KCDP, namely ringnet fishery, prawn fishery, ornamental fishery and lobster fishery
- **Group 2 and 3:** other key commercial species targeted other key fisheries including basket traps, gillnets, handlines, trolling, and longlines, octopus and crab fisheries

Table 8. Priority list of key commercial species as identified through the SICA/PSA process

Group	Family	Scientific Name	Common Name
Demersals (14)	Pomacentridae	<i>Amphiprion allardi</i>	Twobar anemonefish
	Labridae	<i>Cheilinus trilobatus</i>	Tripletail wrasse
	Serranidae	<i>Epinephelus merra</i>	Honeycomb grouper
	Leiognathidae	<i>Leiognathus equula</i>	Tassel fish
	Scaridae	<i>Leptoscarus vaigiensis</i>	Marbled parrotfish
	Lethrinidae	<i>Lethrinus harak</i>	Thumbprint emperor
	Lutjanidae	<i>Lethrinus nebulosus</i>	Spangled emperor
	Lutjanidae	<i>Lutjanus fulviflamma</i>	Dory snapper
	Acanthuridae	<i>Paracanthurus hepatus</i>	Blue tang
	Mullidae	<i>Parapenaeus macronema</i>	Long barbel goatfish
	Mullidae	<i>Mulloidichthys flavolineatus</i>	Yellowstrip goatfish
	Haemulidae	<i>Plectorhinchus schotaf</i>	Minstrel sweetlips
	Pomacanthidae	<i>Pomacanthus chrysurus</i>	Gold tail angelfish
Siganidae	<i>Siganus sutor</i>	Shoemaker spinefoot	
Pelagics (8)	Carangidae	<i>Carangoides ferdau</i>	Blue trevally
	Coryphaenidae	<i>Coryphaena hippurus</i>	Dorado / Common dolphinfish
	Scombridae	<i>Euthynnus affinis</i>	Kawakawa/Mackerel tuna
	Scombridae	<i>Scomberomorus commersoni</i>	Narrow-barred Spanish mackerel
	Sphyrnidae	<i>Sphyrna jello</i>	Pick-handle baracuda
	Carcharhinidae	<i>Sphyrna lewini</i>	Scalloped hammer head
	Myliobatidae	<i>Manta birostris</i>	Manta ray
Myliobatidae	<i>Aeotobatus narinari</i>	Spotted eagle ray	
Cephalopods (3)	Octopodidae	<i>Octopus vulgaris</i>	Common octopus
	Sepiidae	<i>Cuttlefish sp</i>	Cuttlefish
	Lolingidae	<i>Squid sp</i>	Squids
Crustaceans (10)	Penaeidae	<i>Fenneropenaeus indicus</i>	Banana prawn
	Penaeidae	<i>Penaeus monodon</i>	Tiger prawn
	Palaemonidae	<i>Macrobrachium rude</i>	Hairy river prawn
	Palaemonidae	<i>Macrobrachium scabriculum</i>	Goda river prawn
	Atyidae	<i>Caridina nilotica</i>	Darwin algae shrimp
	Panuliridae	<i>Panulirus ornatus</i>	Ornate spiny lobster
	Panuliridae	<i>Panulirus homarus</i>	Scalloped spiny lobster
	Panuliridae	<i>Puerulus angulatus</i>	Lobster
	Portunidae	<i>Scylla serrata</i>	Mudcrab
Portunidae	<i>Portunus pelagicus</i>	Flower crab	
Holothurians (1)	Holothuriidae	<i>Holothuria nobilis</i>	Black teatfish

Table 9. Priority list of key commercial species selected for assessment under KCDP

Group 1	Group 2	Group 3
 <p>1. <i>Panulirus ornatus</i></p>	 <p>5. <i>Siganus sutor</i></p>	 <p>9. <i>Leptoscarus vaigiensis</i></p>
 <p>2. <i>Amphiprion allardi</i></p>	 <p>6. <i>Octopus vulgaris</i></p>	 <p>10. <i>Lutjanus fulviflamma</i></p>
 <p>3. <i>Fenneropenaeus indicus</i></p>	 <p>7. <i>Euthynnus affinis</i></p>	 <p>11. <i>Lethrinus nebulosus</i></p>
 <p>4. <i>Carangoides ferdau</i></p>	 <p>8. <i>Sphyrna lewini</i></p>	 <p>12. <i>Mulloidichthys flavolineatus</i></p>
		 <p>13. <i>Scylla serrata</i></p>

Appendix 1: Summary of the actual values for the fish species that were ranked as high (>3.18) or and medium (2.64 < risk value < 3.18) by fishery

	Fishery	Taxa	Target/Bycatch	Family	Species	Common name	Productivity score	Susceptibility score	2D Overall risk value (P&S) (multiplicative)	2D P&S Overall risk ranking
1	Lobsters	Crustacean	Target	Panuliridae	<i>Panulirus ornatus</i>	Ornate spiny lobster	2.143	3.687	3.687	High
2	Ornamental	Teleost	Target	Pomacanthidae	<i>Pomacanthus maculosus</i>	Yellowbar angelfish	2.143	3.000	3.687	High
3	Ornamental	Teleost	Target	Pomacanthidae	<i>Pomacanthus chrysurus</i>	Goldtail angelfish	2.143	3.000	3.687	High
4	Ornamental	Teleost	Target	Pomacentridae	<i>Amphiprion allardi</i>	Twobar anemonefish	2.000	3.000	3.606	High
5	Ornamental	Teleost	Target	Acanthuridae	<i>Amphiprion akallopisos</i>	Skunk clownfish	2.000	3.000	3.606	High
6	Ringnet	Teleost	Target	Carangidae	<i>Gnathanodon speciosus</i>	Golden Trevally	3.000	3.000	3.538	High
7	Beachseine	Teleost	Target	Sphyraenidae	<i>Sphyraena barracuda</i>	Great Barracuda	2.600	2.333	3.493	High
8	Ringnet	Teleost	Target	Carangidae	<i>Carangoides ferdau</i>	Blue trevally	3.000	3.000	3.473	High
9	Beachseine	Teleost	Target	Lutjanidae	<i>Lutjanus fulviflamma</i>	Dory snapper	1.667	3.000	3.432	High
10	Beachseine	Teleost	Target	Mullidae	<i>Mulloidichthys flavolineatus</i>	Yellowstrip goatfish	1.600	3.000	3.400	High
11	Longline	Chondrichthyan	Target	Carcharinidae	<i>Sphyrna lewini</i>	Hammerhead shark	2.429	2.333	3.368	High
12	Longline	Chondrichthyan	Target	Carcharinidae	<i>Carcharhinus albimarginatus</i>	Silvertip shark	2.429	2.333	3.368	High
13	Longline	Chondrichthyan	Target	Carcharinidae	<i>Carcharhinus melanopterus</i>	Blacktip reef shark	2.429	2.333	3.368	High
14	Sea cucumber	Crustacean	Target	Holothuriidae	<i>Holothuria nobilis</i>	Black teatfish	2.429	2.333	3.368	High
15	Beachseine	Teleost	Target	Apogonidae	<i>Fowleria aurita</i>	Crosseyed cardinalfish	1.400	3.000	3.311	High
16	Beachseine	Teleost	Target	Apogonidae	<i>Ostorhincus thermalis</i>	Half-barred cardinal	1.400	3.000	3.311	High
17	Sea cucumber	Crustacean	Target	Holothuriidae	<i>Holothuria fuscogilva</i>	White teatfish	2.714	1.889	3.207	High
18	Ornamental	Teleost	Target	Tetraodontidae	<i>Balistoides conspicillum</i>	Clown triggerfish	2.286	2.333	3.266	High
19	Ringnet	Teleost	Target	Carangidae	<i>Seriola lalandi</i>	Yellowtail amberjack	2.333	2.333	3.241	High
20	Gillnet fishery	Chondrichthyan	Target	Myliobatidae	<i>Manta birostris</i>	Manta ray	2.231	1.222	3.239	High
21	Gillnet fishery	Chondrichthyan	Target	Carcharinidae	<i>Sphyrna lewini</i>	Scalloped hammer head	2.231	1.222	3.239	High
22	Lobsters	Crustacean	Target	Panuliridae	<i>Panulirus homarus</i>	Scalloped spiny lobster	2.143	3.168	3.168	Med
23	Coastal lakes	Crustacean	Target	Atyidae	<i>Cardina nilotica</i>	Canary dentex	2.857	1.296	3.137	Med
24	Gillnet fishery	Chondrichthyan	Target	Myliobatidae	<i>Aeotobatus naninari</i>	Spotted eagle ray	2.857	1.222	3.108	Med
25	Ornamental	Teleost	Target	Tetraodontidae	<i>Pseudobalistes fuscus</i>	Yellow spotted triggerfish	2.429	1.889	3.077	Med
26	Lobsters	Crustacean	Target	Panuliridae	<i>Puerulus angulatus</i>	Banded whip lobster	2.714	3.075	3.075	Med
27	Lobsters	Crustacean	Target	Panuliridae	<i>Scyllarides squammosus</i>	Blunt slipper lobster	2.714	3.075	3.075	Med
28	Lobsters	Crustacean	Target	Panuliridae	<i>Scyllarides tridacnophaga</i>	Clamkiller slipper lobster	2.714	3.075	3.075	Med
29	Lobsters	Crustacean	Target	Panuliridae	<i>Thanus orientalis</i>	Slipper lobster	2.714	3.075	3.075	Med
30	Beachseine	Teleost	Target	Lutjanidae	<i>Lutjanus argentimaculatus</i>	Mangrove red snapper	2.000	2.333	3.073	Med
31	Ornamental	Teleost	Target	Tetraodontidae	<i>Paraacanthurus hepatus</i>	Palette surgeonfish	2.000	2.333	3.073	Med
32	Ornamental	Teleost	Target	Pomacentridae	<i>Ostracion melepis</i>	White spotted boxfish	2.000	2.333	3.073	Med
33	Ornamental	Teleost	Target	Ostraciidae	<i>Ostracion cubicus</i>	Yellow boxfish	2.000	2.333	3.073	Med
34	Ringnet	Teleost	Target	Scombidae	<i>Scomberomarus commerson</i>	Narrow-barred Spanish mackerel	2.333	2.333	3.073	Med
35	Coastal lakes	Crustacean	Target	Palaemonidae	<i>Macrobrachium rude</i>	Meagre	2.857	1.099	3.061	Med
36	Coastal lakes	Crustacean	Target	Palaemonidae	<i>Macrobrachium scabrinsculum</i>	Axillary seabream	2.857	1.099	3.061	Med
37	Coastal lakes	Crustacean	Target	Atyidae	<i>Cardina africana</i>	Senegal seabream	2.857	1.099	3.061	Med
38	Prawn fishery	Teleost	bycatch	Leiognathidae	<i>Leiognathus equula</i>	Tassel fish	2.571	1.593	3.025	Med
39	Coastal lakes	Teleost	Target	Protopteridae	<i>Protopterus aethiopicus aethiopi</i>	Marbled lungfish	2.714	1.296	3.008	Med
40	Beachseine	Teleost	Target	Fistulariidae	<i>Fistularia commersonii</i>	Bluespotted cornetfish	2.500	1.667	3.005	Med
41	Basket trap	Teleost	Target	Mullidae	<i>Parupeneus trifasciatus</i>	Scissor-tail sergeant	2.714	1.222	2.977	Med
42	Beachseine	Teleost	Target	Gerreidae	<i>Gerres oyena</i>	Common silver biddy	1.833	2.333	2.967	Med
43	Ornamental	Teleost	Target	Tetraodontidae	<i>Arothron mappa</i>	Map puffer	2.286	1.889	2.965	Med
44	Ornamental	Teleost	Target	Labridae	<i>Labroides dimidiatus</i>	Bluestreak cleaner Wrasse	2.286	1.889	2.965	Med
45	Prawn fishery	Teleost	bycatch	Mullidae	<i>Upeneus sulphureus</i>	common threadfin	2.286	1.889	2.965	Med
46	Basket trap	Teleost	Target	Haemulidae	<i>Plectorhynchus schotaf</i>	Peacock hind	2.500	1.593	2.964	Med
47	Sea cucumber	Crustacean	Target	Holothuriidae	<i>Holothuria fuscopunctata</i>	Elephant's trunk fish	2.714	1.148	2.947	Med
48	Ornamental	Teleost	Target	Carangidae	<i>Gnathanodon speciosus</i>	Golden trevally	2.714	1.132	2.941	Med
49	Ringnet	Teleost	Target	Carangidae	<i>Seriola lalandi</i>	Yellowtail amberjack	2.250	1.889	2.938	Med
50	Coastal lakes	Chondrichthyan	Target	Protopteridae	<i>Protopterus amphibius</i>	Blacktip shark	2.714	1.099	2.928	Med
51	Coastal lakes	Chondrichthyan	Target	Protopteridae	<i>Protopterus annectens</i>	Gulper shark	2.714	1.099	2.928	Med
52	Sea cucumber	Crustacean	Target	Holothuriidae		Chalkfish	2.714	1.099	2.928	Med
53	Sea cucumber	Crustacean	Target	Holothuriidae		Amberfish	2.714	1.074	2.919	Med
54	Ringnet	Teleost	Target	Carangidae	<i>Elagatus bipinnulata</i>	Rainbow runner	2.333	2.333	2.917	Med
55	Longline	Chondrichthyan	Target	Scombidae	<i>Galeocerdo cuvier</i>	Tiger shark	2.429	1.593	2.904	Med
56	Longline	Chondrichthyan	Target	Scombidae	<i>Carcharhinus longimanus</i>	Oceanic whitetip Shark	2.429	1.593	2.904	Med
57	Prawn fishery	Teleost	Target	Penaetidae	<i>Fenneropenaeus indicus</i>	Indian white prawn	1.714	2.333	2.895	Med
58	Prawn fishery	Teleost	Target	Penaetidae	<i>Penaeus monodon</i>	Tiger prawn	1.714	2.333	2.895	Med
59	Prawn fishery	Teleost	Target	Penaetidae	<i>Metapenaeus monoceros</i>	Speckled prawn	1.714	2.333	2.895	Med
60	Prawn fishery	Teleost	Target	Penaetidae	<i>Penaeus japonicus</i>	Kuruma prawn	1.714	2.333	2.895	Med
61	Prawn fishery	Teleost	Target	Penaetidae	<i>Penaeus semisulcatus</i>	Green tiger prawn	1.714	2.333	2.895	Med
62	Trolling	Chondrichthyan	Target	Istiophoridae	<i>Istiompax indica</i>	Scalloped hammerhead	2.714	1.000	2.893	Med
63	Trolling	Chondrichthyan	Target	Istiophoridae	<i>Makaira mazara</i>	Shortfin mako	2.714	1.000	2.893	Med
64	Sea cucumber	Crustacean	Target	Holothuriidae	<i>Thelonata ananas</i>	Prickly redfish	2.571	1.296	2.880	Med
65	Lobsters	Crustacean	Target	Panuliridae	<i>Panulirus longipes</i>	Longlegged spiny lobster	2.143	2.857	2.857	Med
66	Ornamental	Teleost	Target	Dasyatidae	<i>Taeniura lymna</i>	Ribbontail stingray	2.143	1.889	2.857	Med
67	Ornamental	Teleost	Target	Tetraodontidae	<i>Arothron nigropunctatus</i>	Blackspotted puffer	2.143	1.889	2.857	Med
68	Ornamental	Teleost	Target	Tetraodontidae	<i>Chaetodon falcula</i>	Saddleback butterflyfish	2.143	1.889	2.857	Med
69	Ornamental	Teleost	Target	Pomacanthidae	<i>Pomacanthus imperator</i>	Emperor angelfish	2.143	1.889	2.857	Med
70	Ornamental	Teleost	Target	Pomacanthidae	<i>Pomacanthus semicirculatus</i>	Semicircle angelfish	2.143	1.889	2.857	Med

Appendix 1 continued

	Fishery	Taxa	Target/Bycatch	Family	Species	Common name	Productivity score	Susceptibility score	2D Overall risk value (P&S) (multiplicative)	2D P&S Overall risk ranking
71	Ornamental	Teleost	Target	Carangidae	<i>Arothron stellatus</i>	Stellate puffer	2.143	1.889	2.857	Med
72	Prawn fishery	Teleost	bycatch	Mullidae	<i>Upeneus tragula</i>	Blackstriped goatfish	2.143	1.889	2.857	Med
73	Longline	Chondrichthyan	Target	Carcharinidae	<i>Carcharhinus melanopterus</i>	Black tip reef shark	2.571	1.222	2.847	Med
74	Ringnet	Teleost	Target	Scombridae	<i>Rastrelliger kanarguta</i>	Indian mackerel	2.333	2.333	2.843	Med
75	Beachseine	Teleost	Target	Plotosidae	<i>Plotosus lineatus</i>	Striped eel catfish	1.600	2.333	2.829	Med
76	Prawn fishery	Teleost	bycatch	Leiognathidae	<i>Secutor insidiator</i>	Slender soapfish	2.429	1.444	2.826	Med
77	Sea cucumber	Crustacean	Target	Holothuriidae	<i>Holothuria (Halodeima) atra</i>	Blackfish	2.571	1.148	2.816	Med
78	Sea cucumber	Crustacean	Target	Holothuriidae	<i>Stichopus variegatus</i>	Curryfish	2.571	1.148	2.816	Med
79	Sea cucumber	Crustacean	Target	Holothuriidae		Leopard fish	2.571	1.148	2.816	Med
80	Beachseine	Teleost	Target	Lethrinidae	<i>Lethrinus spp</i>	Emperors	1.571	2.333	2.813	Med
81	Ornamental	Teleost	Target	Scorpaenidae	<i>Dendrochirus zebra</i>	Zebra turkeyfish	2.429	1.395	2.801	Med
82	Ornamental	Teleost	Target	Scorpaenidae	<i>Dendrochirus brachypterus</i>	Shortfin turkeyfish	2.286	1.593	2.786	Med
83	Sea cucumber	Crustacean	Target	Holothuriidae	<i>Holothuria (Halodeima) edulis</i>	Pinkfish	2.571	1.049	2.777	Med
84	Beachseine	Teleost	Target	Hemiramphidae	<i>Hemiramphus far</i>	Black-barred halfbeak	1.500	2.333	2.774	Med
85	Trolling	Chondrichthyan	Target	Istiophoridae	<i>Kajikia audax</i>	Shark, Tiger	2.571	1.000	2.759	Med
86	Coastal lakes	Chondrichthyan	Target	Schilbeidae	<i>Schilbe mystus</i>	Daisy stingray	2.429	1.296	2.753	Med
87	Coastal lakes	Crustacean	Target	Northobranchiidae	<i>Northobranchius willerti</i>	Striped shrimp	2.429	1.296	2.753	Med
88	Basket trap	Teleost	Target	Lethrinidae	<i>Lethrinus variegatus</i>	Yellow boxfish	2.000	1.889	2.751	Med
89	Ornamental	Teleost	Target	Chaetodontidae	<i>Chaetodon guttatissimus</i>	Peppered butterflyfish	2.000	1.889	2.751	Med
90	Ornamental	Teleost	Target	Chaetodontidae	<i>Chaetodon leucopleura</i>	Somali butterflyfish	2.000	1.889	2.751	Med
91	Ornamental	Teleost	Target	Chaetodontidae	<i>Chaetodon xanthocephalus</i>	Yellowhead butterflyfish	2.000	1.889	2.751	Med
92	Ornamental	Teleost	Target	Pomacentridae	<i>Chaetodon dolosus</i>	African butterflyfish	2.000	1.889	2.751	Med
93	Ornamental	Teleost	Target	Scorpaenidae	<i>Pterois antennata</i>	Spotfin lionfish	2.000	1.889	2.751	Med
94	Ornamental	Teleost	Target	Scorpaenidae	<i>Pterois miles</i>	Devil firefish	2.000	1.889	2.751	Med
95	Ornamental	Teleost	Target	Scorpaenidae	<i>Pterois radiata</i>	Clearfin lionfish	2.000	1.889	2.751	Med
96	Ornamental	Teleost	Target	Acanthuridae	<i>Zebbrasoma veliferum</i>	Sailfin tang	2.000	1.889	2.751	Med
97	Ornamental	Teleost	Target	Acanthuridae	<i>Zebbrasoma desjardini</i>	Desjardin's sailfin tang	2.000	1.889	2.751	Med
98	Ornamental	Teleost	Target	Chaetodontidae	<i>Chaetodon zanzibarensis</i>	Zanzibar butterflyfish	2.000	1.889	2.751	Med
99	Prawn fishery	Teleost	bycatch	Mullidae	<i>Upeneus vittatus</i>	white sea catfish	2.000	1.889	2.751	Med
100	Ringnet	Teleost	Target	Scombridae		King mackerel	1.889	1.889	2.751	Med
101	Ringnet	Teleost	Target	Hemiramphidae	<i>Hemiramphus sp</i>	Bigwing halfbeak	1.889	1.889	2.751	Med
102	Basket trap	Teleost	Target	Lethrinidae	<i>Lethrinus microdon</i>	Smalltooth emperor	2.333	1.444	2.744	Med
103	Basket trap	Teleost	Target	Lethrinidae	<i>Lethrinus obsoletus</i>	Lined rabbitfish	2.333	1.444	2.744	Med
104	Ornamental	Teleost	Target	Labridae	<i>Coris aygula</i>	Clown coris	2.429	1.263	2.738	Med
105	Ornamental	Teleost	Target	Lutjanidae	<i>Macolor niger</i>	Black and white snapper	2.429	1.263	2.738	Med
106	Coastal lakes	Teleost	Target	Schilbeidae	<i>Parailia somalensis</i>	African red snapper	2.429	1.198	2.708	Med
107	Coastal lakes	Teleost	Target	Cichlidae	<i>Oreochromis spilurus</i>	African forktail snapper	2.286	1.444	2.704	Med
108	Prawn fishery	Teleost	bycatch	Engraulidae	<i>Thryssodes malabaricus</i>	Malabar thryssa	2.286	1.444	2.704	Med
109	Prawn fishery	Teleost	bycatch	Engraulidae	<i>Thryssa setirostris</i>	Longjaw thryssa	2.286	1.444	2.704	Med
110	Prawn fishery	Teleost	bycatch	Scianidae	<i>Johnius amblycephalus</i>	Bearded croaker	2.286	1.444	2.704	Med
111	Beachseine	Teleost	Target	Siganidae	<i>Siganus spp</i>	Rabbitfish	1.333	2.333	2.687	Med
112	Basket trap	Teleost	Target	Mullidae	<i>Parupeneus barberinus</i>	Shoemaker spinefoot	2.429	1.148	2.686	Med
113	Longline	Chondrichthyan	Target	Xiphiidae	<i>Isurus oxyrinchus</i>	Shortfin mako	2.429	1.148	2.686	Med
114	Ornamental	Teleost	Target	Haemulidae	<i>Plectrohynchus pictus</i>	Trout sweetlips	2.286	1.395	2.678	Med
115	Ornamental	Teleost	Target	Monacanthidae	<i>Oxymonacanthus longirostris</i>	Harlequin filefish	2.143	1.593	2.670	Med
116	Ornamental	Teleost	Target	Labridae	<i>Bodianus anthioides</i>	Lyretail hogfish	2.143	1.593	2.670	Med
117	Ornamental	Teleost	Target	Blenniidae	<i>Ecsenius midas</i>	Persian blenny	2.143	1.593	2.670	Med
118	Ornamental	Teleost	Target	Blenniidae	<i>Meiacanthus mossambicus</i>	Mozambique fangblenny	2.143	1.593	2.670	Med
119	Ornamental	Teleost	Target	Blenniidae	<i>Exallias brevis</i>	Leopard blenny	2.143	1.593	2.670	Med
120	Ornamental	Teleost	Target	Labridae	<i>Coris formosa</i>	Queen coris	2.143	1.593	2.670	Med
121	Basket trap	Teleost	Target	Siganidae	<i>Siganus lineatus</i>	Golden lined spinefoot	1.286	2.333	2.664	Med
122	Basket trap	Teleost	Target	Siganidae	<i>Siganus sutor</i>	Shoemaker spinefoot	1.286	2.333	2.664	Med
123	Basket trap	Teleost	Target	Siganidae	<i>Siganus canaliculatus</i>	White spotted spinefoot	1.286	2.333	2.664	Med
124	Sea cucumber	Crustacean	Target	Holothuriidae	<i>Actinopyga miliaris</i>	Blackfish	2.429	1.074	2.655	Med
125	Basket trap	Teleost	Target	Lethrinidae	<i>Lethrinus nebulosus</i>	Spangled emperor	1.857	1.889	2.649	Med

6.0 References

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